NEWS &NOTES

National Aeronautics and Space Administration

Volume 38, Number 4

Fourth Quarter 2021

FROM THE ACTING CHIEF HISTORIAN

The year 2021 was eventful for NASA. From the landing of the Perseverance Rover on Mars on 18 February to the launch of the James Webb Space Telescope (JWST) on 25 December, the 12 months of 2021 were some of the most memorable in the Agency's history. The year also included Ingenuity's powered flight on Mars and the launches of Lucy, the Imaging X-ray Polarimetry Explorer (IXPE), the Double Asteroid Redirection Test (DART), and Landsat 9, just to name a few. It was also a big year for the International Space Station—13 spacewalks (the most since 2010), the return of the SpaceX Crew-1 mission, and the completion of the 21st straight year of crew on orbit. The year also saw continued progress on programs including the Space Launch System (SLS), the X-59 Quiet Supersonic Technology, and the X-57 Maxwell All-Electric Aircraft. And those are just some of the highlights.

On the other end of the spectrum, 2021 saw the continuation of COVID-19, as remote work continued in the face of the international pandemic. The prolonged closure of archival collections, both at NASA and across the country, limited the amount of new research conducted—a minor inconvenience when one considers the real impacts the pandemic has wrought in terms of those we've lost along the way. Incredible feats of engineering and

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HISTORICALLY UNIQUE CAPABILITY: THE MARSHALL X-RAY AND CRYOGENICS FACILITY

By Brian Odom

Most everything about the world of high-energy astrophysics is difficult. The math is complex; the margin between risk and failure is narrow; and, once the experiment leaves the launchpad, there is little chance of fixing a problem. The fact that our atmosphere absorbs most x rays is good for us but bad for testing experiments designed to detect them. Luckily, Marshall Space Flight Center (MSFC) developed a solution.

Originally completed in 1976 for testing the x-ray mirrors for the Einstein Observatory (HEAO-2), the X-ray and Cryogenics Facility (XRCF) is a critical and storied pillar of Marshall's infrastructure. Back in 1976, NASA needed a way to recreate the environment x-ray experiments would find once in orbit to test the grazing incidence mirrors. From the outside, the most notable thing about the facility is the 1,700-foot guide tube through which the simulated x-ray sources travel to the main building and the instrument chamber clean room.

As the facility evolved over the decades, it left an imprint on many NASA programs. Numerous rounds of important testing were conducted during the development of the Chandra X-ray Observatory in the late 1980s and 1990s.

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OFFICE OF COMMUNICATIONS

From the Acting Chief Historian (continued)

scientific breakthroughs are seemingly balanced with tragedy and loss.

For the NASA History program, 2021 was also a year of major organizational transformation. The years since 2018 saw an ebb and flow of the NASA Mission Support Directorate's Mission Support Future Architecture Program (MAP) effort. With a goal of creating a more "enterprise" operating model vs. the older decentralized approach, the core philosophical positives of the effort were at times lost within the labyrinth of bureaucratic implacability.

"THIS MODEL WILL ALLOW FOR A MORE INTEGRATED APPROACH TO RESEARCH AND A COLLABORATIVE APPROACH TO PUBLIC COMMUNICATIONS, EXTERNAL RESEARCHERS, AND FUNCTIONAL COHERENCY IN AREAS LIKE PUBLICATIONS AND ORAL HISTORIES."

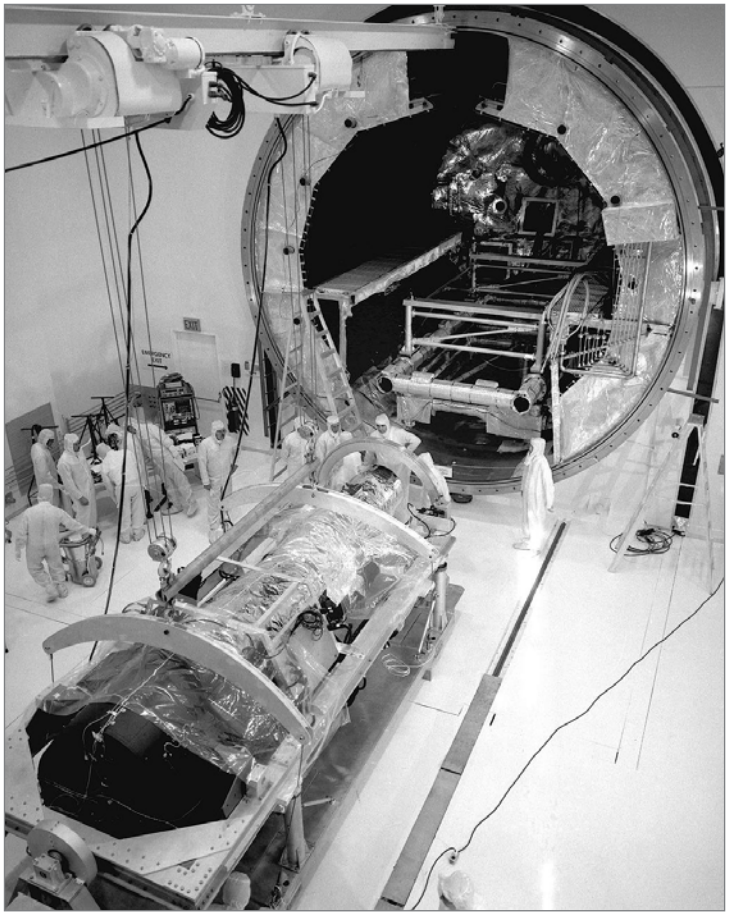
As we move forward in 2022, hope springs eternal. After many years of strategic plotting, collaborative efforts, and passionate appeals, the History program is on the cusp of something new. On the history side of the house, we have developed a model that moves from a decentralized structure to a thematic model aligned not by region or Center, but by the work of the Agency across the Mission Directorates (Human Spaceflight/Operations, Science, Aeronautics, and Space Technology). This model will allow for a more integrated approach to research and a collaborative approach to public communications, external researchers, and functional coherency in areas like publications and oral histories.

The new model also highlights the critical importance of archival collections by following a similar path of integration across the Agency with collaborative tools—tools that are already in place at the Goddard Space Flight Center Archives and under development for expansion across the Agency. This approach will enable Agency archivists to succeed in their primary role—the preservation of historical material and institutional memory created by NASA to enable long-term access to NASA's history.

By taking these steps, we will ensure that both internal and external researchers, from scientists and engineers to academics and the public, will be able to learn about our history not just now, but for years to come. And with years like the one we just had, I can't imagine there will be any shortage of major scientific and engineering breakthroughs anytime soon. The year 2022 will see the Artemis I and Psyche launches, lots of international and commercial space activity, and scientific returns from JWST. With continued support from the Agency and our external stakeholders, the History program will be there to document every step of the way.

Brian C. Odom
Acting Chief Historian

Historically Unique Capability: The Marshall X-ray and Cryogenics Facility (continued)



In 1977, testing occurred in the XRCF for the Einstein Observatory (HEAO-2). This image is of engineers evaluating the observatory in the X-ray and Cryogenic Facility clean room. (Photo credit: NASA)

Six gold-coated beryllium primary mirror segments in their test positions in the cryo vacuum chamber at the X-ray and Cryogenic Facility. (Photo credit: NASA/MSFC/David Higginbotham)

That testing proved critical to the success of that mission, which continues to produce incredible science. In 2002, the XRCF hosted testing of the Solar X-ray Imager (SXI) for the GOES-12 satellite, and, in 2005, it tested the critically important x-ray telescope for Hinode—a mission developed to explore the solar magnetic fields and the forces that drive the dynamic forces of the solar atmosphere. Without the XRCF, mitigating many of the risks associated with those revolutionary missions would have proved impossible.

Several modifications over its 45-year history allow the XRCF to continue to play a vital role in proving out experimental space hardware. One of the more recent missions to go through the XRCF was the James Webb Space Telescope (JWST). From 2008 to 2011, the facility's 7,600-cubic-foot helium-cooled vacuum chamber was used for verification of several components of the observatory, including chilling the JWST mirrors (down to –414°F) and testing the structural stability of the primary mirror segment assemblies and backplane support structure.

As new missions come and go, this Marshall facility stands ready to test x-ray optics, detectors, and telescopes or perform mission-critical technology readiness demonstrations. Whether the goal of a mission is exploring the Sun or looking back to the early formation of the universe, the important work conducted in the XRCF ensures these missions will be prepared for the harsh environments they encounter in space.

NEWS FROM HEADQUARTERS AND THE CENTERS

AMES RESEARCH CENTER (ARC)

Moffett Field, California

By April Gage and James Anderson

On 12 November, *the NASA Experience* opened at Chabot Space and Science Center in Oakland, California. The opening was the result of months of hard work and coordination from multiple organizations across Ames. An immersive and dynamic exhibit, the NASA Experience also serves as a new visitor center for Ames, providing greater visibility and access to the public in the San Francisco Bay Area.

In addition to showcasing the breadth of the work done across the divisions at Ames, many artifacts spanning our 82-year history are on display, including hardware, models, and spacesuits. We offer a hearty congratulations in particular to Cara Dodge, our Center Exhibits Manager, for successfully coordinating so much of this effort.

Our team's achievements these past few months have also been tempered with some profound sadness. In June, we lost our colleague and friend Danielle Carmichael. Danielle joined the Office of Education at Ames in 2014 and, after joining the Office of Communications, coordinated the Speakers Bureau. This role connected her to even more people and groups across the Center and the Agency. The outpouring of support and tributes to her in the wake of her passing are a testament to how beloved and valued she was. Her dedication and effervescent spirit touched the lives of many people, and we are fortunate that she was our colleague.

Another dear colleague, Lynn Albaugh, passed away in early September, after more than 48 years as the photograph archivist at Ames. In addition to her expertise and deep knowledge of Ames and its history, she almost singlehandedly ensured that our Ames family actually felt like a family. Like clockwork, she organized the potlucks and get-togethers that provided such a significant amount of the social glue that has connected and strengthened our team over the years. Anyone who worked with her in person would have experienced immediately the inviting space that she created. She continued to bring this care and compassion (and her no-nonsense demeanor) to our team even over the videoconferencing that has defined so much of our work since early 2020.

“IN ADDITION TO HER EXPERTISE AND DEEP KNOWLEDGE OF AMES AND ITS HISTORY, SHE ALMOST SINGLEHANDEDLY ENSURED THAT OUR AMES FAMILY ACTUALLY FELT LIKE A FAMILY.”

While the past almost two years have presented many challenges and tragedies for families and colleagues, our work continues and there are still other achievements to celebrate. In August, we welcomed two history interns in the Office of Communications who supported the ongoing work for the planned history of the Volatiles Investigating Polar Exploration Rover (VIPER), a lunar rover mission that Ames is leading. Chelsea Wells, a recent graduate of the University of Virginia who majored in foreign affairs and previously interned for NASA's Office of International and Interagency Relations, and Emma Kimble, a history major at Eastern Michigan University, contributed important groundwork that gave them each additional experience sifting through dense and extensive documentation to help contextualize some of VIPER's instrument development. In addition to collecting and refining material for appendices, including various thematic timelines, both drafted alternative text for key imagery in support of a goal to increase the

accessibility of the e-book version of the upcoming history. They presented their work internally in December at the conclusion of the semester, and we wish them continued success in their future endeavors!

ARMSTRONG FLIGHT RESEARCH CENTER (AFRC)

Edwards Air Force Base, California

By Christian Gelzer

We completed the print and electronic versions of the Center's coffee table book, *Flights of Discovery*, to coincide with the Center's 75th anniversary this year. This is the second revision of the book that originally appeared in 1996, created for the Center's 50th anniversary. As with the previous revision, this edition has a new chapter at the end covering the work done since 2006. Because of the jump in printing costs, the Center acquired a relatively small number, and they are expected to be available only within the Center, and not for wide distribution. To still make it available to those who want copies, we have created two electronic versions: a PDF e-book and an interactive e-book, and the latter should be available as this reaches you. Unlike existing e-books, the interactive version has

hyperlinks to videos. In 2019, AFRC entered into a Space Act Agreement with Purdue University so that a group of senior undergraduates majoring in game development could tackle the creation of the interactive version. The four students completed the first draft just before graduating. Because it was not yet complete, the Center hired the lead student, Chris Hollopeter, for six months to complete the book. There is also an audio version of the book that should be available by early 2022, recorded by Ted Huetter, formerly of AFRC and now at the Seattle Museum of Flight.

> **"BECAUSE OF THE ONGOING PANDEMIC AND THE MAJORITY OF THE CENTER'S WORK BEING DONE OFFSITE, AFRC OPTED TO CELEBRATE ITS 75TH ANNIVERSARY OVER AN ENTIRE YEAR, RATHER THAN IN ONE FELL SWOOP."**

Because of the ongoing pandemic and the majority of the Center's work being done offsite, AFRC opted to celebrate its 75th anniversary over an entire year, rather than in one fell swoop. One of the first things we did to start the celebration was open a time capsule, sealed in 1996 and stashed in the cockpit of the X-1E, tail number 6063. The accompanying article by Jay Levine, editor of the *X-Press*, has details of the capsule's contents. Each month the Center is releasing a themed ***video*** about AFRC's work, found on the Center's social media platforms.

Christian Gelzer's current book, *The Enigma of the Bell Spanload: Prandtl, Horten, Jones, Bowers, and the Natural Way to Fly*, is in peer review. The book is a history of the Center's Primary Research on AerodyNamic Design To Lower Drag (PRANDTL-D) project. Ludwig Prandtl and his students developed the standard tool for designing wings, dubbed the elliptical spanload, in 1918. Because it led to the most efficient wing possible, it remains the standard design tool even today. In 1933, Prandtl published an alternate spanload design that was 11.5 times more efficient than the elliptical. Fellow German Reimar Horten independently arrived at a very similar spanloading concept in 1935, although he found control in his design, not efficiency. Horten, of course, is known for a family of all-flying wings, a design that has inherent control problems because it lacks a vertical stabilizer. Despite working on this design for decades, Horten published only one article about his efforts, and it was thin on details. AFRC aero engineer Al Bowers wanted to validate the control aspect of the alternate spanload (the wing's efficiency gains are self-evident in the design). He relied principally on student interns since he had no direct funding from either the Center or ARMD. The project flew 4 large radio-controlled aircraft with instrumentation and 18 small aircraft, some also with instrumentation, to validate Horten's contention that his "bell" spanload generated thrust at the wingtips instead of adverse yaw. In 2013, the project validated Horten's assertion. Because of its greater efficiency and control potential, the spanload could dramatically reduce aircraft operation costs. The enigma is that between 1933 and 1973 there was only one citation of his paper. There were two more in 1973 and 1975, but nothing came of it even then. The alternate spanload is virtually unknown today. One well-known German aeronautics professor (a Prandtl student once removed) considers it a fraud. It remained almost entirely ignored for more than 60 years, and its gradual socialization only came as a result of Bowers's tireless proselytizing for it. Even now, skeptics abound—within and without NASA. This project was the first to explore the concept with an actual aircraft.

Meanwhile, Gelzer is finishing the research for the draft of a history of the Controlled Impact Demonstration (CID) the Center flew in 1984. It was Curtis Peebles's last book project. CID (often referred to by Center personnel as the "Crash In the Desert") was a project

Al Bowers (far right) and student interns pose with the last Prandtl-D wing variant on Rosamond Dry Lake at Edwards Air Force Base (AFB). (Photo credit: Christian Gelzer)

sponsored by the Federal Aviation Administration (FAA) to demonstrate an anti-misting additive to jet fuel that was expected to reduce port-crash fires in airliners. After four years of engineering and modification to a Boeing 720 (a long-range version of the 707) provided by the FAA, the plane was flown via radio control on a short flight from the base's main runway to an intentional crash on the lakebed at Edwards Air Force Base (AFB). Rather than no post-crash fire, on impact the aircraft erupted in flames that took multiple refills by the base fire trucks to extinguish. The FAA, which had planned to issue a requirement later that same month requiring U.S. airliners to begin modifying their aircraft to use the additive, quietly erased it from its memory. But the aircraft carried a variety of other experiments on board, some of which transferred to commercial airlines we fly on today. Post-crash fires, once a serious problem, happen rarely today, and there is no push for any fuel additive to eliminate them.

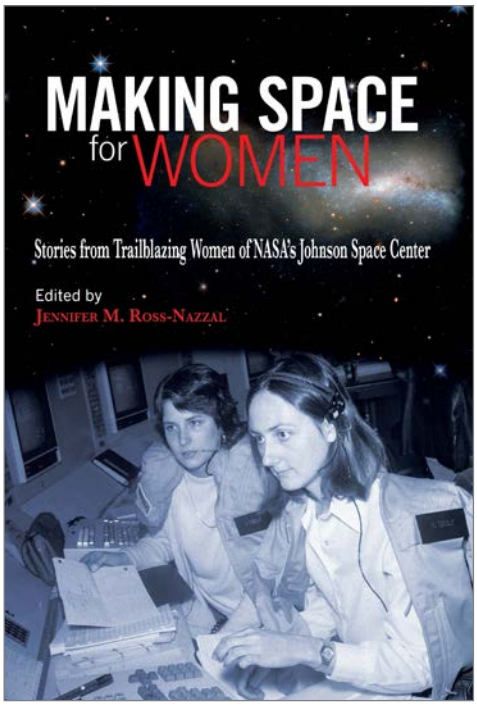
JOHNSON SPACE CENTER (JSC)

Houston, Texas

By John Uri

Johnson Space Center (JSC) in Houston and the White Sands Test Facility in Las Cruces, New Mexico, continue to operate at Stage 2 of NASA's COVID response framework, with the Center occupancy cap raised to 50% on 15 November 2021. The JSC History Office continues to operate in a hybrid manner, with John Uri, Jennifer Ross-Nazzal, and Sandra Johnson dividing their time between onsite work and telework as activities demand.

We are happy to announce the publication of Jennifer Ross-Nazzal's book *Making Space for Women: Stories from Trailblazing Women of NASA's Johnson Space Center* by the Texas A&M University Press! The book explores how careers for women at JSC have changed over the years, as told by the women themselves through oral histories conducted by the JSC History



Cover of *Making Space for Women*. (Image credit: Texas A&M University Press)

Office. Just before the holidays, Jennifer spoke about her book to an audience in Space Center Houston's Mission Briefing Room. Steve Garber of NASA Headquarters nominated the book for the Organization of American Historians Mary Nickliss Prize in U.S. Women's and/or Gender History, and Texas A&M is working to nominate the book for the Society for History in the Federal Government member award. Interest in the subject is growing. The JSC 60th Anniversary Celebrations Team invited Jennifer to participate in a panel discussion, along with some of the individuals included in the book, for an anniversary event, and JSC's Women Excelling in Life & Leadership Employee Resource Group also requested that she speak for Women's History Month in March 2022.

Sandra and Jennifer continue to conduct oral history interviews both in person, with appropriate safety protocols in place, and in the Microsoft Teams environment. Jennifer continued a series of interviews with astronaut Shannon Lucid covering her entire career. Sandra has conducted interviews as part of a project initiated by the acting NASA Chief Historian to interview key senior staff under former NASA Administrator Jim Bridenstine. These included former and current Associate Administrator for

Jennifer Ross-Nazzal speaking at Space Center Houston about her book. (Photo credit: John Uri)

Human Exploration and Operations Bill Gerstenmaier and Kathy Lueders, respectively; former Associate Administrator Steve Jurczyk; former Deputy Associate Administrator Melanie Saunders; and Administrator Bridenstine's Chief of Staff, Gabe Sherman. Jennifer and Sandra continue to process transcripts from already-completed interviews to add them to the *JSC History Portal* throughout the year.

The JSC History Office has begun participating in a joint oral history project with historian Erik Conway at the Jet Propulsion Laboratory to capture the history of NASA's Discovery Program in anticipation of its 30th anniversary. After completing preparatory work, Sandra has scheduled the first interviews to begin in January 2022.

"THE JSC HISTORY OFFICE HAS BEGUN PARTICIPATING IN A JOINT ORAL HISTORY PROJECT WITH HISTORIAN ERIK CONWAY AT THE JET PROPULSION LABORATORY TO CAPTURE THE HISTORY OF NASA'S DISCOVERY PROGRAM...."

The JSC History Office was involved in several outreach activities. Jennifer gave a virtual talk entitled "Eisenhower and the Space Program" at the Eisenhower Presidential Library, Museum & Boyhood Home in Abilene, Kansas. In addition to the *talk*, Jennifer promoted the event on several local radio shows and a podcast. She also contributed to a *Nichelle Nichols tribute video*. NASA hired Nichols, who played Lt. Uhura in the original television series *Star Trek*, to encourage women and minorities to apply for NASA's first Space Shuttle astronaut class. John participated in a Reddit Ask Me Anything (AMA) session about the Moonikin radiation mannequin flying aboard the Artemis 1 mission and named after NASA flight controller Arturo Campos, who was instrumental in successfully bringing the Apollo 13 astronauts home safely. John was invited to join the AAS History Committee by the chair, Michael Ciancone.

And congratulations to Jennifer, who in December 2021 graduated from the University of North Texas with a master's degree in information science!

The JSC History Office is working with JSC's External Relations Office to help the Center celebrate its 60th anniversary. A series of articles about JSC's history are published on the nasa.gov/history site and on JSC's social media pages. The first virtual panel discussion for JSC's 60th anniversary has been posted to the JSC homepage (*First Johnson 60th Anniversary Panel Discussion*). The JSC "Houston, We Have a Podcast" episode about JSC's 60th anniversary is posted at *Ep. 223: NASA's 60 Years in Houston | NASA*.

We continue to work with the JSC External Relations Office to publish a series of articles commemorating significant historical milestones, such as the 50th anniversary of Apollo 15, the 40th anniversary STS-2, and special features for Hispanic Heritage Month and about how astronauts celebrate Halloween, Thanksgiving, Christmas, and Hanukkah in space. Erik Conway, historian at the Jet Propulsion Laboratory, supported three articles commemorating the anniversaries of three Mars exploration spacecraft. The articles appear on the *www.nasa.gov* website and JSC's social media accounts. Select articles appeared as features on JSC's *Roundup Reads*, and abstracts of the articles appeared in *Roundup Today*, JSC's online daily newsletter. The features often highlight the anniversaries of less heralded events and the people who were important in the various spaceflight endeavors. In September, we reached a significant milestone with the publication of the 400th article since the series began in August 2017.

TWO NASA ARMSTRONG EMPLOYEES RECALL BUILDING TIME CAPSULE

By Jay Levine

Andy Blua and Don Whitfield stand by the time capsule they helped construct 25 years ago at NASA Armstrong Flight Research Center during the Center's 50th anniversary. It was recently opened at the Center, located in Edwards, California, on 13 October 2021. The time capsule was opened as part of the activities commemorating the Center's 75th anniversary. (Photo credit: NASA/Joshua Fisher)

In 1995, at NASA's Armstrong Flight Research Center in Edwards, California, a time capsule was needed. Machinists Andy Blua and Tom McMullen and welders Ed Swan and Don Whitfield were instructed to follow engineering drawings and build the container that would securely hold artifacts for a quarter century.

Once complete, the time capsule was loaded with the items provided by the Center's organizations and sealed on the Center's 50th anniversary in 1996.

Fast forward to 13 October 2021, when the Center was celebrating its 75th anniversary and *the capsule items were unloaded*. NASA Administrator Bill Nelson, NASA Deputy Administrator Pam Melroy, NASA Armstrong Center Director David McBride, and Deputy Director Pat Stoliker reviewed the treasures stored for a new generation of Center employees.

Blua and Whitfield, who still work at the Center, were there as the artifacts they helped safely store were unpacked.

"I don't often realize what I am working on, or its significance," Blua said.

In fact, the men had forgotten all about the time capsule until recently, when it was announced that it would be opened. Whitfield added that they also had no idea what was in it.

Budgets, plans, and technical papers were in the capsule, which also included an aerial photo of the Center, an 8-inch data-storage floppy disk that was no longer in use by the late 1970s, a punch card last seen routinely in the mid-1980s, a research aircraft fleet image, a VHS video, photos of research aircraft, and a staff photo taken behind the Center's Hangar 4802.

In addition, other encapsulated items included Hispanic Heritage Program photos, the *Flights of Discovery* book, and the Center's strategic plan. Perhaps the most treasured part of the collection was about 30 entries that included text and drawings from local schoolchildren, called Aeronautics 2020, on what they thought the future would look like.

While the time capsule has secured items for 25 years and will be doing so again to open on the Center's 100th anniversary, Blua and Whitfield have proposed improvements. For example, the capsule did not fit well into the X-1E cockpit, which is where it was stored just outside the Center's main administration building.

While it is uncertain what items might be selected for the time capsule, one thing is sure—it will stand the test of time.

NASA Administrator Bill Nelson shows a picture of the X-3 to NASA Armstrong Flight Research Center Director David McBride on 13 October. NASA Armstrong Deputy Center Director Patrick Stoliker and NASA Deputy Administrator Pam Melroy also are with Nelson and McBride. The X-3 photo was contained in a time capsule that was sealed on the Center's 50th anniversary and opened to commemorate its 75th anniversary. (Photo credit: NASA/Joshua Fisher)

NASA AND THE BLACKBIRD PROJECT

By Aishwarya Sukumaran
NASA History Summer/Fall Intern 2021

Lockheed Martin's SR-71 Blackbird is one of the most iconic aircraft to come out the Cold War era. It remains one of the world's fastest aircraft, and it still holds the official world record for the fastest air-breathing crewed aircraft, which it set in 1976. As the successor to the CIA's A-12 Archangel, the SR-71 was used in the Cold War for reconnaissance by the Air Force. Lockheed engineers tested prototype airframes of the A-12 at NASA's Ames Research Center, which marked the start of NASA's involvement with the Blackbird project. Later, Lockheed also developed an interceptor version of the A-12, known as the YF-12A, which was canceled due to the success of the SR-71 Blackbird as a reconnaissance aircraft. Despite the termination of the YF-12 program, NASA used the YF-12A along with one SR-71A from 1969 to 1979 for a variety of high-speed tests.

"YF-12C" in the foreground, with YF-12A in the background. (Photo credit: NASA)

TESTING FROM 1969 TO 1979

NASA had initially requested to place instrumentation in the SR-71 to collect in-flight data but was turned down by Lockheed due to concerns about extra maintenance. Eventually, NASA was officially loaned two YF-12As from the Air Force to use for research purposes in 1969. NASA used the aircraft to research structural heating and flight loads at a sustained cruise speed of Mach 3 to help in the development of supersonic cruise aircraft. The aircraft carried a crew of two, one pilot and flight engineer, of which NASA had two research pilots—Fitzhugh Fulton and Donald Mallick—and two flight engineers—Victor Horton and Ray Young—who conducted flight testing from the NASA Flight Research Center (now Armstrong Flight Research Center). The Air Force also had a team of pilots who flew the aircraft as needed. In June 1971, one of the YF-12s experienced a malfunction that led to a fire in the right engine. Both crew members managed to eject and were uninjured, but the YF-12 could not be saved as it crashed in the California desert. That YF-12A was replaced by a "YF-12C," which had a distinct look compared to the A model. It was later revealed that the "YF-12C" was actually an SR-71, painted with an A-12 tail number.

The loaned SR-71 was used in the 1970s to help researchers understand Space Shuttle landing dynamics because it handled similarly to the Shuttle when in a high-drag configuration. Both aircraft were also used as flying laboratories for various experiments,

including pollution studies, noise suppression, and sonic boom testing. Additionally, NASA was interested in the possibility that the "YF-12C" could launch a hypersonic drone from a dorsal mount. Engineers modified the aircraft with hard points and changes to the fuel tank to maintain a stable center of gravity and proposed the use of an HT-4 Hypersonic Drone that could launch at the YF-12's cruise altitudes. NASA tests would make it possible for Lockheed to produce the M-21 and D-21 mother ship and drone version of the A-12 Archangel. Eventually, the project was discontinued due to a fatal accident, killing test pilot Ray Torick and forcing NASA to rule out any subsequent drone launches from the M-21. The SR-71 would serve as a chase aircraft for the YF-12A during the notable Coldwell experiments and would finish its time with NASA as a test aircraft for a Cooperative Airframe/Propulsion Control System (CAPCS) in 1978.

After being retired by the U.S. Air Force in 1990, three SR-71 Blackbirds found their way back to NASA in the early '90s at Dryden (now Armstrong) Flight Research Center. One of the aircraft was later taken back by the Air Force in 1995 for further reconnaissance work, but NASA was able to keep the SR-71B (NASA 831)—a trainer version of the Blackbird—and one SR-71A (NASA 844) for testing purposes. Because the Blackbird was no longer a classified project, NASA was able to collaborate with universities and organizations to conduct various experiments that would later inform designers for future supersonic aircraft, both commercial and military. The NASA SR-71 Program included projects and experiments that worked to rebuild the ozone layer, test commercial satellite wireless networks, and prototype reusable launch vehicles.

LOCKHEED LASRE

The Lockheed Martin Linear Aerospike SR-71 Experiment (LASRE) was a project conducted by NASA in conjunction with Lockheed Martin and Rocketdyne to collect data and determine the aerodynamic performance of a potential reusable launch vehicle (RLV). That proposed RLV was the X-33, a prototype space plane developed in partnership with NASA and Lockheed. At the time of the experiments, the Linear Aerospike Engine—critical to the X-33's project success—required testing.

Lockheed Martin X-33 concept art. (Image credit: NASA)

The Linear Aerospike Engine (LAE) was envisioned as a propulsion system that was lightweight yet powerful enough to allow for flight. NASA collaborated with Lockheed Martin to develop the LAE using data from Rocketdyne in the 1960s and '70s and produced an engine that was quite different from the conventional rocket engine. Instead of a bell nozzle that would constrict expanding gases, the LAE looked like a bell turned inside out and upside down and laid flat. The engine had a series of small combustion chambers along the unwrapped bell that shot

Adding the LASRE pod on the back of the SR-71. (Photo credit: NASA/Tony Landis)

hot gases to produce thrust (thus giving it the name "Linear Aerospike").

The LASRE experiment was a data collection project for the Linear Aerospike Engine, which would in turn power the X-33—a reusable launch vehicle prototype designed by Lockheed Martin and NASA.

The X-33 was an unpiloted aircraft and would demonstrate new technology in flight, such as a new lifting body shape, a linear aerospike engine, and a metallic thermal protection system. This new technology would have lowered the cost of bringing a pound of payload to space from $10,000 to $1,000.[1]

In order to provide data on the potential performance of both the X-33 and the Linear Aerospike Engine, the SR-71 Blackbird was used as a testbed for the engine. Researchers mounted a 20%-scale version of the X-33 and the aerospike engine onto the back of the Blackbird, with the primary objective of collecting installed-engine in-flight test data to compare to wind tunnel data.[2, 3]

FLIGHT TESTING AND RESULTS

To allow the SR-71 to carry the linear aerospike engine, modifications were made to the aircraft structure, flight test instrumentation, aircraft fuel system, and aircraft propulsion system. For the aircraft structure, the

1. Monroe Conner, "Lockheed Martin X-33," NASA (NASA, 30 March 2016), *https://www.nasa.gov/centers/armstrong/history/experimental_aircraft/X-33.html*.
2. Stephen Corda et al., "Flight Testing the Linear Aerospike SR-71 Experiment (LASRE)" (Washington, DC: National Aeronautics and Space Administration, 1998).
3. *SR-71 LASRE Linear Aerospike SR-71 Experiment* (National Aeronautics and Space Administration, 15 February 1996), *https://www.dfrc.nasa.gov/Gallery/Photo/SR-71-LASRE/HTML/EC96-43419-25.html*.

Ground cold flow test of the linear aerospike rocket engine mounted on the rear fuselage of an SR-71. (Photo credit: NASA/Tony Landis)

fuselage was strengthened, and new attachment hardware was installed to allow the Blackbird to carry the LASRE.[4] New plumbing additions were also installed to supply nitrogen gas from the SR-71 to the LASRE during the tests to prevent oxygen buildup and mitigate the possibility of fire or explosion. Propulsion modifications included the installation of two thrust-enhanced Pratt & Whitney J58 turbojet engines to help overcome the additional drag caused by the LASRE.[5]

Extensive preparations included flight simulations, ground testing, wind tunnel testing, and an incremental flight test program that involved flying the SR-71 with and without the LASRE attachment. The incremental tests allowed researchers to understand how the SR-71 and the experiment would react individually. Researchers used wind tunnel testing to understand the aerodynamic characteristics of the LASRE pod and used ground tests (shown in the photo) to properly time the flow of liquids between the Blackbird and the LASRE.[6] The SR-71 and the LASRE pod completed seven flights in total over the course of the experiment. The first two flights were to see how nitrogen and helium would cycle through the experiment to check for leaks. The other five tested the experiment itself, but only in a cold flow configuration. NASA discontinued the LASRE experiment due to cost-cutting measures before hot flow tests were able to be completed.

THE FUTURE OF THE LINEAR AEROSPIKE ENGINE AND THE SR-71 BLACKBIRD

NASA discontinued the X-33 program in 2001, partially due to cost-cutting measures as well as issues with its composite liquid hydrogen tank.[7] Thus, the linear aerospike engine that was tested with the LASRE project was no longer being considered for use in the form of an RLV. However, the testing and further development of the aerospike engine did not end with the X-33, and other organizations have continued to make progress. Notably, in 2004, NASA

“THE TESTING AND FURTHER DEVELOPMENT OF THE AEROSPIKE ENGINE DID NOT END WITH THE X-33, AND OTHER ORGANIZATIONS HAVE CONTINUED TO MAKE PROGRESS.”

4. Stephen Corda et al., “Flight Testing the Linear Aerospike SR-71 Experiment (LASRE)” (Washington, DC: National Aeronautics and Space Administration, 1998), p. 4.
5. Ibid.
6. Stephen Corda et al., “Flight Testing the Linear Aerospike SR-71 Experiment (LASRE)” (Washington, DC: National Aeronautics and Space Administration, 1998), p. 16.
7. Brian Dunbar, “X-33,” NASA (NASA, 19 August 2015), *https://www.nasa.gov/centers/dryden/multimedia/imagegallery/X-33/X-33_proj_desc.html*.

sponsored two successful tests in conjunction with the Blacksky Corporation, called the Dryden Aerospike Rocket Test.[8]

After the termination of the LASRE program in 1999, the SR-71 Blackbird flew one last time with NASA's flight crew at the Edwards Air Force Base air show in the same year.[9] The SR-71 trainer that was used by NASA (NASA 831) is on display at the Pima Air and Space Museum in Tucson, Arizona, and the SR-71A (NASA 844) is displayed at Armstrong Flight Research Center in Edwards, California.[10, 11]

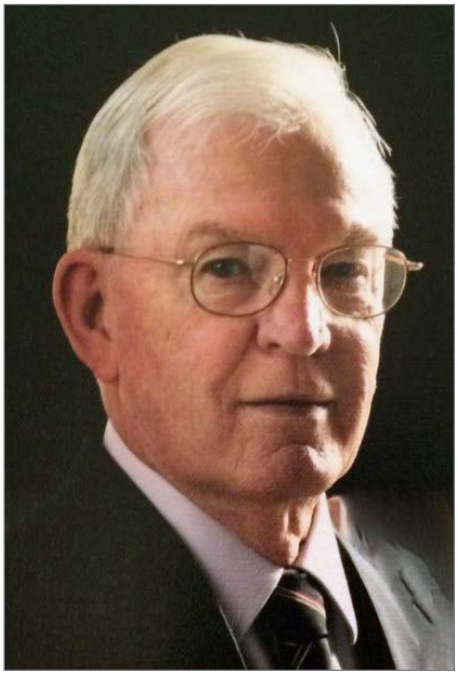
8. Brian Dunbar, "Pointy End Up? With Aerospike Rockets, It's Down, Too!" NASA (NASA, 26 April 2004), *https://www.nasa.gov/missions/research/aerospike_rocket.html*.
9. Peter Merlin, "Lockheed SR-71A (61-7980 / NASA 844) Flight Log" (Washington, DC: NASA, 2002).
10. Monroe Conner, "Where Are They Now: SR-71 #831," NASA (NASA, 20 October 2015), *https://www.nasa.gov/centers/armstrong/history/where_are_they_now/SR-71_831.html*.
11. Monroe Conner, "Where Are They Now: SR-71A #844," NASA (NASA, 20 October 2015), *https://www.nasa.gov/centers/armstrong/history/where_are_they_now/SR-71A_844.html*.

IN MEMORIAM

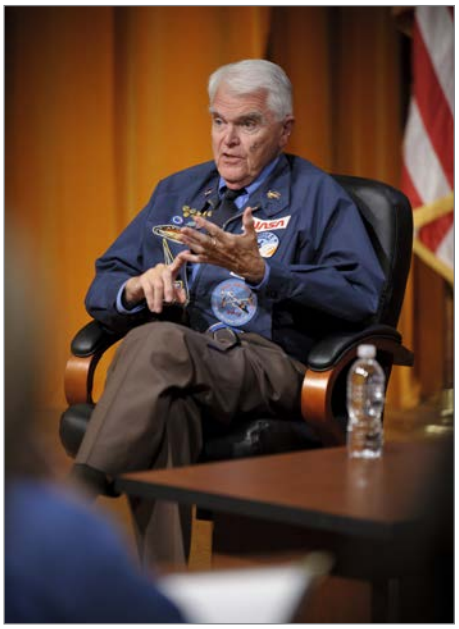
W. DAVID COMPTON

By John Uri

We were saddened to hear of the passing of W. David Compton on 22 January 2022, in Athens, Georgia, at the age of 94. David, a native Texan with B.S. and M.S. degrees in chemistry from North Texas State College and a Ph.D. in chemistry from the University of Texas, worked in the History Office at NASA's Johnson Space Center in Houston as a contract writer. He authored two official NASA histories, ***Living and Working in Space: A History of Skylab*** (with Charles Benson), NASA SP-4208, published in 1983, and ***Where No Man Has Gone Before: A History of NASA's Apollo Lunar Expeditions***, NASA SP-4214, published in 1989. In between those two book contracts, he wrote the chapter on NASA and space sciences in *100 Years of Science and Technology in Texas*, published in 1986 by Sigma Xi for its centenary and Texas's sesquicentennial. David received the Dr. Robert H. Goddard Historical Essay Prize at the National Space Club's 1983 Goddard Memorial Dinner. His works contributed significantly to the space history literature.



W. David Compton. (Photo courtesy of *https://www.dignitymemorial.com/obituaries/athens-ga/william-compton-10544220*)



Dr. Hans Mark, NASA Ames Director (1969–77), photo taken 16 September 2008. (Credit: NASA/Dominic Hart)

HANS MARK

By James Anderson

In December last year, Hans Mark passed away. A former Deputy Administrator from 1981 to 1984 and the third Center Director of Ames Research Center, Mark dedicated his career to public service in ways that shaped the Agency and the nation.

Born in Mannheim, Germany, in 1929, Mark escaped from Austria with his family in 1940 and moved to New York, becoming a citizen in 1945. Intrigued by scientific and technological advancements the world was witnessing, Mark studied physics at the University of California (UC), Berkeley, and earned his doctorate in the field from the Massachusetts Institute of Technology in 1954. He moved between the two institutions over the next 15 years, serving as a research physicist at UC's Lawrence Radiation Laboratory in Livermore until 1958, then as an assistant professor of physics at MIT before returning to head the Livermore Lab's Experimental Physics Division from 1960 until 1964. He then chaired Berkeley's Department of Nuclear Engineering and later

became administrator of the Berkeley Research Reactor. He joined Ames as its Center Director in 1969.

At that time, theoretical work in fluid flow was advancing. Mark had seen firsthand great leaps in computing capability while at Livermore, and he and others agreed that the state of the art in computing had reached a point that could profoundly impact fluid mechanics work. The Computational Fluid Dynamics Branch was created at Ames, and Mark took advantage of government computers about to be declared surplus. He also persuaded the Advanced Research Projects Agency (ARPA) to place the Illiac IV at Ames. The Illiac IV was a crucial component of the development of computational fluid dynamics, one of NASA's most significant contributions in the aerospace field. By 1976, Ames was poised to solidify its position within NASA as the place for supercomputing, a legacy that continues to this day.

Mark also oversaw the development of a long and productive partnership with the Army for joint research in vertical takeoff and landing. A key development was the XV-15, an experimental tiltrotor that led to the V-22, an aircraft capable of taking off and landing like a helicopter and flying as a turboprop plane. Mark moved on from Ames in 1977 to serve as Under Secretary of the Air Force until July 1979, when he was promoted to Secretary. He soon returned to NASA in 1981, when he was appointed Deputy Administrator and the Space Shuttle had just begun to fly.

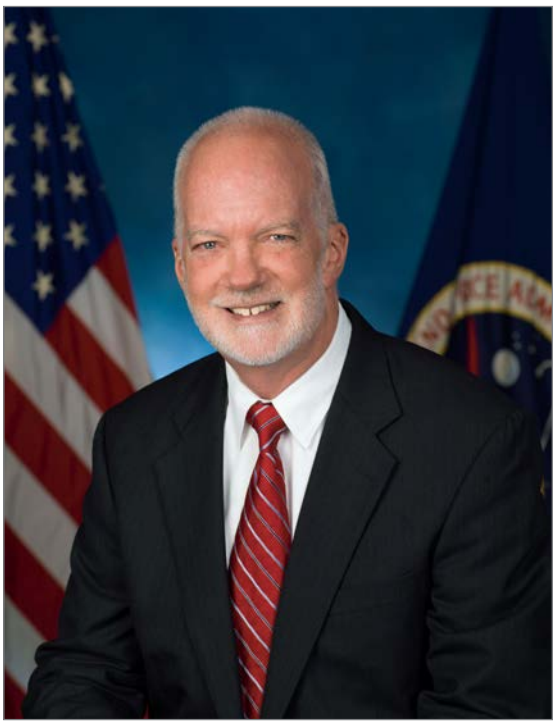
Upon leaving NASA in 1984, Mark served as Chancellor of the University of Texas (UT) system until 1992. Aside from continuing to advise the government, Mark remained connected to the UT system, teaching aerospace engineering and inspiring generations of students.

The Austin American-Statesman *reports that memorial gifts can be made to the Hans Mark Scholarship Endowment at the University of Texas.*

Mark's tenure is covered in the most recent edition of ***Atmosphere of Freedom*** *on pages 9 to 13.*

JOHN CHARLES

By John Uri



John Charles. (Photo credit: NASA)

I first met John in 1985. I was immediately impressed by his overwhelming and infectious enthusiasm for spaceflight. We had just met, but he sensed in me a fellow space cadet and took me to Mission Control so I could watch the STS-51D astronauts try to salvage a satellite during an unscheduled spacewalk. While we watched the EVA, we got to chatting about our common interest in space, and especially its biomedical aspects. He told me that Story Musgrave's work had inspired him to earn his doctorate in physiology and biophysics at the University of Kentucky. John had just completed a two-year fellowship at Johnson Space Center (JSC) and become a civil servant in the cardiovascular lab at JSC.

I have many fond memories of John over the decades from various chapters in our respective careers. At times, we worked directly together; at others, I admired his work from a distance. With our interests in the

Russian space program, we both became involved in the Shuttle-Mir Program from its earliest beginnings in 1992. This led to numerous trips to Russia over the next several years, and I still remember his unbounded excitement when he first saw the Russian Chibis Lower Body Negative Pressure device, something we had all read about but now he was finally able to see and operate firsthand. I remember one episode when, tired of the endless negotiations, John and I decided to strike out on our own at Star City, which in those early days wasn't really done. Anyway, we stumbled into the buildings housing the crew centrifuge and the Hydrolab, the large pool where cosmonauts train for EVAs, and managed not to start an international incident with our unescorted explorations. I may have at least partially contributed to his career change from a full-time researcher to a research manager when I requested his help as a mission scientist for the NASA 4 and 5 missions of Jerry Linenger and Mike Foale aboard Mir, a job that he took on with his usual boundless energy and enthusiasm.

John's next assignments included serving as the mission scientist for STS-95, which saw John's childhood hero astronaut John Glenn return to space in 1998 after 36 years, and for STS-107, the last fateful flight of Space Shuttle Columbia in 2003. We would often run into each other in the Mission Control Center and compare notes about how our respective simulations or missions were going, as I was working in the International Space Station program at the time. John later earned the eminent position of Chief Scientist for the Human Research Program (HRP), and our careers crossed paths again as I managed the space radiation element for HRP for four years. John continued to be an outstanding scientist and excellent manager to work with, lending much encouragement when I needed it most. He also led the scientific effort behind the One-Year Mission of astronaut Scott Kelly and cosmonaut Mikhail Korniyenko in 2015–16, including the unique studies conducted with Scott and his twin brother, astronaut Mark Kelly.

I joined hundreds of well-wishers at John's retirement party in 2018 at Space Center Houston (SCH). After

"JOHN CONTINUED TO BE AN OUTSTANDING SCIENTIST AND EXCELLENT MANAGER TO WORK WITH, LENDING MUCH ENCOURAGEMENT WHEN I NEEDED IT MOST."

35 years at NASA, he had decided it was time for a change, but we all knew he couldn't turn his back on space. Indeed, SCH hired John as their first scientist in residence. I was fortunate to see John frequently in his new role, as he hosted many of SCH's Thought Leader Series and other events, and he was always kind to take the time to introduce me to any speakers I didn't know. As president of the American Academy of Matrimonial Lawyers, my wife Susan hosted an event for them at SCH, including a dinner to which we naturally invited John as a guest. In his typical generous fashion, and without being asked, John took it upon himself to provide an impromptu and enthusiastic 1-hour tour of SCH's exhibits to many very appreciative lawyers.

John published more than 60 scientific papers about cardiovascular physiology in space. As a space history enthusiast, he also published numerous articles on that subject and spoke at various venues. I relied on his expertise on such subjects as the U.S. Air Force's Manned Orbiting Laboratory, early Apollo spacesuits, the use of neutral buoyancy for spacewalk training, the Lunar Receiving Laboratory, and many others. I still rely on his publications, as well as the ***oral histories*** that he so generously provided to the JSC History Office.

Over the years, my wife and I attended several Riders in the Sky concerts with John and his wife Kathy. They just won't be the same without him.

Ad astra, John.

UPCOMING MEETINGS

The American Astronautical Society's annual Goddard Memorial Symposium will be held virtually and in Greenbelt, Maryland, **16–18 March 2022**. Visit *https://astronautical.org/events/goddard* for more details.

The annual meeting of the National Council on Public History will be held in Montreal, Quebec, **23–27 March 2022**. Visit *https://www.ncph.org* for more details.

The annual Spring Meetings of the International Astronautical Federation will be held in Paris, France, **29–31 March 2022**. Visit *http://www.iafastro.org* for more details.

The annual meeting of the Organization of American Historians will be held virtually and in Boston, Massachusetts, **31 March to 3 April 2022**. Visit *https://www.oah.org* for more details.

The biennial Policy History Conference will be held in Tempe, Arizona, **1–4 June 2022**. Visit *https://jph.asu.edu/conferences* for more details.

The annual meeting of the Society for History in the Federal Government will be held in Shepherdstown, West Virginia, **2–3 June 2022**. Visit *http://www.shfg.org/annual-meeting* for more details.

The annual meeting for the Society of American Archivists will be held in Boston, Massachusetts, 20–27 August 2022. See *https://www2.archivists.org/conference/* for more details.

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OTHER AEROSPACE HISTORY NEWS

AMERICAN ASTRONAUTICAL SOCIETY (AAS) HISTORY COMMITTEE

By Michael Ciancone

2020 Emme Award for Astronautical Literature

The **Emme Award**—named for NASA's first Historian, recognizes outstanding books that advance public understanding of astronautics based on originality, scholarship, and readability. The Emme Award Panel, chaired by **Dr. Don Elder**, guided the review of submitted and solicited titles. Other members of the Panel are **Dr. Rick Sturdevant**, **Dr. Jennifer Levasseur**, and **Dr. De Witt Kilgore**.

In addition, the Panel selects recipients for the **Emme Junior Award**, which considers books written specifically for children (K–5) and young adults (6–12) to recognize efforts to inspire and educate today's students (and future leaders) through publications aimed at K–12 students.

The Panel has selected the following recipients for the 2020 Emme Awards:

- Emme Award: **Teasel Muir-Harmony**, *Operation Moonglow: A Political History of Project Apollo* (Basic Books)
- Emme Junior Award: **John Rocco**, *How We Got to the Moon: The People, Technology, and Daring Feats of Science Behind Humanity's Greatest Adventure* (Crown Books for Young Readers)

2021 Ordway Award for Sustained Excellence in Spaceflight History

The Ordway Award is named in memory of Frederick I. Ordway III (1927–2014), human spaceflight advocate and chronicler of the history of rocketry and space travel. The award recognizes exceptional, sustained efforts to inform and educate on spaceflight and its history through one or more media, such as 1) writing, editing, or publishing; 2) preparation and/or presentation of exhibits; or 3) production for distribution through film, television, art, or other non-print media. The award is managed by the Ordway Panel of the AAS History Committee. Members of the Panel are **Michael Ciancone (Chair)**, **Robert Godwin**, **Dr. Valerie Neal**, **Ron Miller**, **Dr. Roger Launius** (2020 recipient), **Bill Ingalls** (2020 recipient), and **Rachel Tillman** (2020 recipient).

The 2021 recipients of the Ordway Award are as follows:

- **Asif A. Siddiqi, Ph.D.**, is recognized for sustained excellence as a prolific scholar of Soviet space history and the broader aspects of space exploration on a global scale.
- **Robert Z. Pearlman** is recognized for his unique and broad contributions to the preservation of spaceflight history, creating communities of spaceflight professionals and fans from around the globe on his online platform and through writing, film, and activities that reach all ages and levels of interest, creating the strong human interest that feeds national and international commitment.

International Academy of Astronautics History Series

Univelt has all materials in hand for **IAC 2018** (Bremen, Volume Editor: **Hannes Mayer**) and **IAC 2019** (DC, Volume Editor: **Oti Liepack**). Publication of the AAS History Series by Univelt will end with the publication of the 2019 volume.

Membership Updates

The Committee welcomed several new members: **Dr. Erik Conway** (JPL Chief Historian), **Dr. Jennifer Levasseur** (Smithsonian National Air and Space Museum), **Dr. Teasel Muir-Harmony** (Smithsonian National Air and Space Museum), **Dr. Brian Odom** (NASA Chief Historian [acting]), and **John Uri** (JSC History Office).

CALL FOR PAPERS: HISTORY OF NASA AND THE ENVIRONMENT SYMPOSIUM

Date: 29–30 September 2022
Location: Georgetown University/Hybrid
Organizers: NASA, Georgetown University, and New Jersey Institute of Technology

> *NASA is called the space agency, but in a broader sense, we could be called an environmental agency…. Virtually everything we do, manned or unmanned, science or applications, helps in some practical way to improve the environment of our planet and helps us understand the forces that affect it.*
>
> —NASA Administrator James Fletcher to Congress, March 1973

To more critically analyze the historical connection between NASA and the environment, the NASA History Office and Georgetown University invite proposals for papers to be presented at a two-day symposium, 29–30 September at Georgetown University, Washington, DC. The purpose of the symposium is to analyze the long history of NASA's interest in, responses to, exploration of, and impact upon environments as broadly construed. The planning committee thus welcomes papers exploring NASA's relationship to environments on Earth, on other planetary bodies, and in deep space, as well as papers undertaking a variety of methodological approaches, including not only the history of science, environmental history, and the history of technology, but also social, cultural, political, economic, legal, and other types of historical analysis. Diverse scholars at every seniority level are encouraged to apply, and the organizers are pleased to provide funding for hotel accommodations for two nights near the university.

Possible topics for papers include, but are not limited to, the following:

- NASA and the Environmental Movement
- NASA and Environmental Justice/Inequality
- Environmental Impact of NASA Technology and Development
- International Collaboration/Global Environment
- Space Exploration and Human Health/Biology
- Environmental History of NASA Facilities
- NASA Responses to Environmental Changes on Earth and in Space
- Cultural Histories of NASA and the Environment
- Earth and Space Photography/Art
- Environmental Analog Sites/Artificial Landscapes
- Earth Observing Technologies
- Remote Sensing and Geographic Information Systems
- Earth Science Applications/Missions/Policies
- NASA and Climate Change Science
- Planetary Sciences
- Planetary Protection Protocols
- History of Exobiology/Astrobiology
- Environmental Control and Life Support Systems
- Orbital Debris/Space Junk
- Environmental History of Space Colonies
- Decadal Planning
- Biographies of NASA Earth/Space Scientists

The format of the symposium will be a combination of panel discussions, keynote talks, and group discussion. The intention is to publish an anthology of selected papers.

Submission Procedures: If you wish to present a paper, please send an abstract of no more than 400 words and a short biography or curriculum vitae, including affiliation, by 1 July 2022 to:

Dr. Brian C. Odom
NASA
brian.c.odom@nasa.gov

Dr. Dagomar Degroot
Georgetown University
dagomar.degroot@georgetown.edu

Dr. Neil Maher
New Jersey Institute of Technology
maher@njit.edu

IMAGE IN NASA HISTORY

This photo, taken in 1962, shows Dr. Hans Mark, Director of NASA Ames Research Center from 1969 to 1977 and NASA Deputy Administrator from 1981 to 1984, in his office with his secretary, Edie Watson. (Photo credit: NASA/Lee Jones)

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